3.5 Fire Resistance

3.5.1 Rationale

Simulates exposure of RESS to fire from the outside of the vehicle due to e.g. a fuel spill from a vehicle (either the vehicle itself or a nearby vehicle). This situation should leave the driver and passengers with enough time to evacuate and no explosion should occur in a later stage.

3.5.2 Requirement

The test is required for RESS to be placed at a level less than 1.5 m above ground. The test is carried out on one item as compared to R34 Annex 5 where 3 items are required.

3.5.2.1. Conditions

3.5.2.1.1. The state of charge (SOC) of RESS shall be at the maximum which is possible during normal vehicle operation. If for some reason another SOC would pose a higher risk then this SOC should be used.

3.5.2.1.2. The RESS shall have a temperature equal to the maximum allowed operating temperature before the test starts. If there is reason to believe that any other temperature would pose a higher risk than this temperature should be used.

3.5.2.1.3. The RESS shall be installed in a testing fixture simulating actual mounting conditions as far as possible; no combustible material should be used for this except the material that is part of the RESS. The method whereby the RESS is fixed in the fixture shall correspond to the relevant specifications for its installation. In the case of RESS designed for a specific vehicle use, vehicle parts which affect the course of the fire in any way shall be taken into consideration.

3.5.2.1.4 The cooling system and the venting systems for prevention of overpressure shall remain operative during the test.

3.5.2.1.5. The flame to which the RESS is exposed shall be obtained by burning Heptane in a pan. The quantity of Heptane poured into the pan shall be sufficient to permit the flame, under free-burning conditions, to burn for the whole test procedure, i.e. at least 25 litres/m². Water should be poured at the bottom of the pan to ensure a flt bottom of the pan. The pan dimensions shall be chosen so as to ensure that the sides of the RESS are exposed to the flame. The pan shall therefore exceed the horizontal projection of the RESS by at least 20 cm, but not more than 50 cm. The sidewalls of the pan shall not project more than 8 cm above the level of the Heptane at the start of the test.

In cases when the RESS is distributed over the vehicle it is possible to run the test on each subpart of the RESS.

Comment: Heptane is chosen to make the test more reproducible

3.5.2.1.6. The pan filled with Heptane shall be placed under the RESS in such a way that the distance between the level of the Heptane in the pan and the RESS bottom corresponds to the design height of the RESS above the road surface at the unladen mass. Either the pan, or the testing fixture, or both, shall be freely movable.

3.5.2.1.7. During phase C of the test, the pan shall be covered by a screen placed 3 cm +/- 1 cm above the Heptane level. The screen shall be made of a refractory material, as prescribed in Appendix 2. There shall be no gap between the bricks and they shall be supported over the Heptane pan in such a manner that the holes in the bricks are not obstructed. The length and width of the frame shall be 2 cm to 4 cm smaller than the interior dimensions of the pan so that a gap of 1 cm to 2 cm exists between the frame and the wall of the pan to allow ventilation. Before the test the screen shall be heated to 308 K +/- 5 K (35 degrees C +/- 5

degrees C). The firebricks may be wetted in order to guarantee the repeatable test conditions.

3.5.2.1.8. The tests should be carried out in an ambient temperature of at least 20 ℃. If the tests a re carried out in the open air, sufficient wind protection shall be provided and the wind velocity at pan level shall not exceed 2.5 km/h.

3.5.2.1.9. The test shall comprise of four phases (see Appendix 1).

3.5.2.1.7.1. Phase A: Pre-heating (figure 1)
The Heptane in the pan shall be ignited at a distance of at least 3 m from the RESS being tested. After 60 seconds pre-heating, the pan shall be placed under the RESS. If the size of the pan is too large to be moved without risking liquid spills etc. then the RESS and test rig can be moved instead of the pan.

3.5.2.1.7.2. Phase B: Direct exposure to flame (figure 2)
For 90 seconds the RESS shall be exposed to the flame from the freely burning Heptane.

Comment: A longer testing time is chosen here in recognition of the normal spread in testing results according to R34 and only one test is conducted here.

3.5.2.1.7.3. Phase C: Indirect exposure to flame (figure 3)
As soon as phase B has been completed, the screen shall be placed between the burning pan and the RESS. The RESS shall be exposed to this reduced flame for a further 90 seconds.
Instead of conducting Phase C of the test, Phase B may be continued for additional 90 seconds at the manufacturer's discretion in those cases there is no reason to believe that this might pose a lower risk than the normal phase C.

3.5.2.1.4. Phase D: End of test (figure 4)
The burning pan covered with the screen shall be moved back to its original position (phase A). No extinguishing of the RESS shall be done. The RESS should be monitored for 1h after the removal of the pan.

3.5.2.2 Acceptance criteria

During Phase A to D of the test, the RESS shall not explode or rupture and no venting shall occur during phase A-C.

Comment: The no venting criteria is important to allow safe evacuation from the vehicle as the RESS is in some cases connected to the passenger compartment by e.g. use of the air from the passenger compartment for cooling the RESS.

3.5.3 Verification

The explosion criterion is verified by visual inspection. By no explosion means no sudden large increase in flames, no rapid release of energy, no pressures wave and no flying parts.

The venting criteria is evaluated either by signal from the BMS or if this is not possible by some other indication as agreed between the technical service and the customer, this could be achieved by e.g. measuring gases produced during the test.

1.1 Annex 5 - Appendix 1

TEST OF RESISTANCE TO FIRE

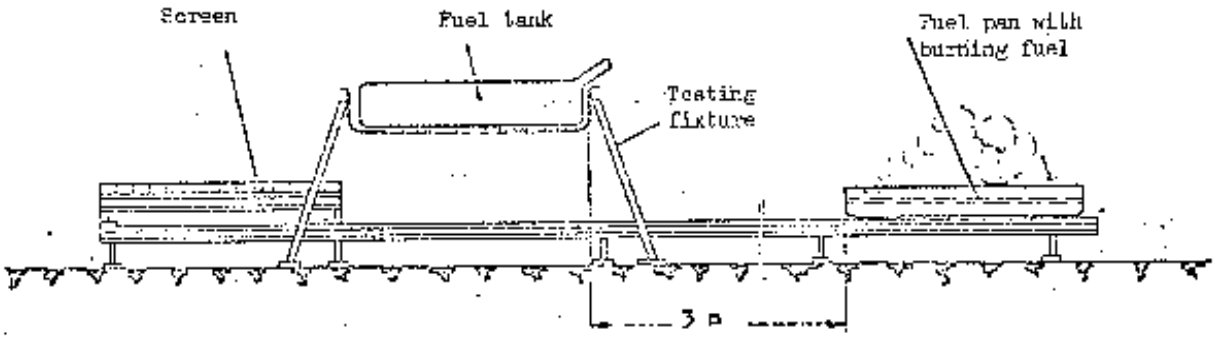

Figure 1
Phase A: Pre-heating

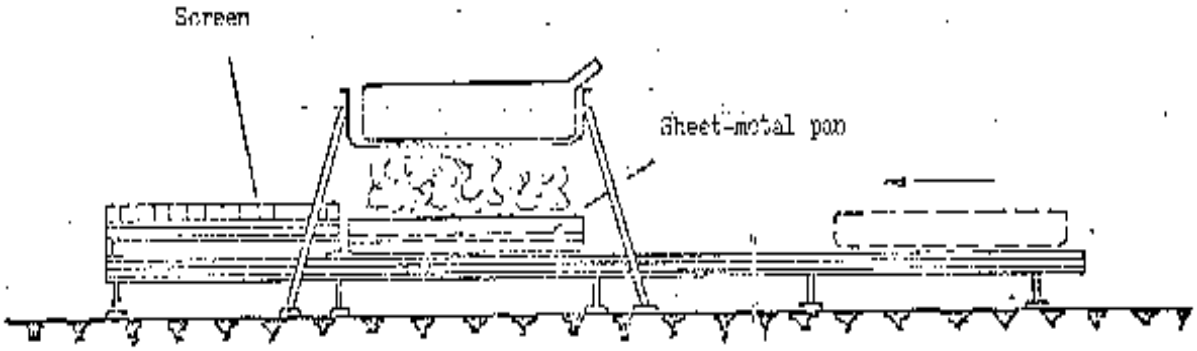

Figure 2
Phase B: Direct exposure to flame

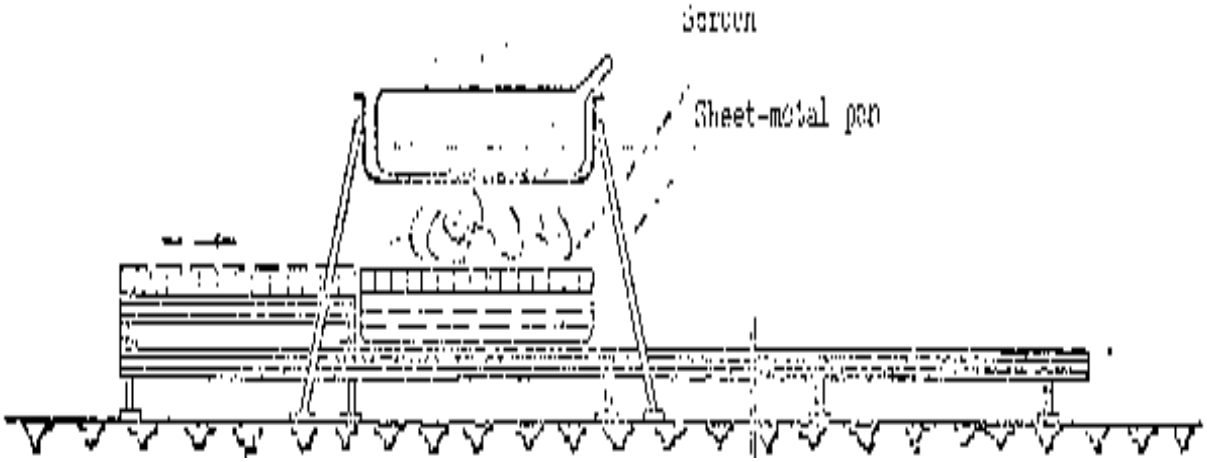

Figure 3
Phase C: Indirect exposure to the flame

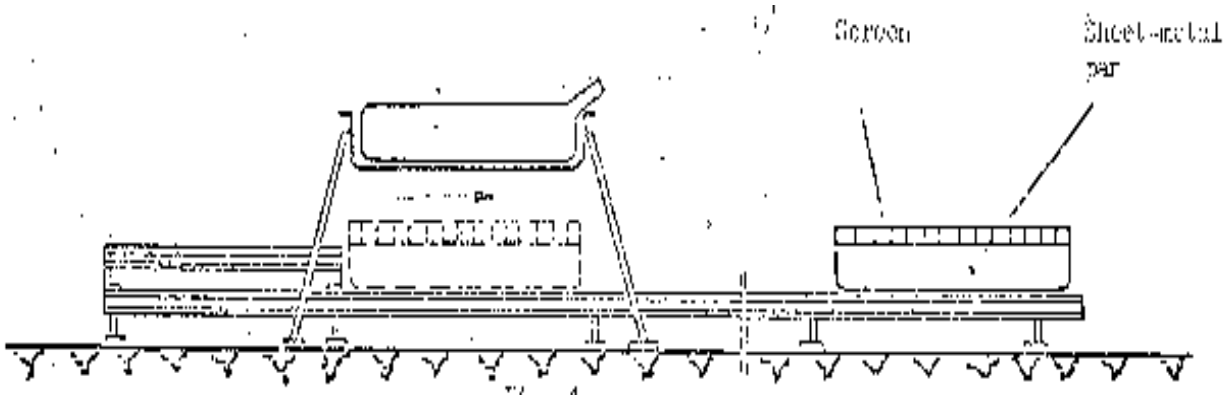

Figure 4
Phase D: End of test

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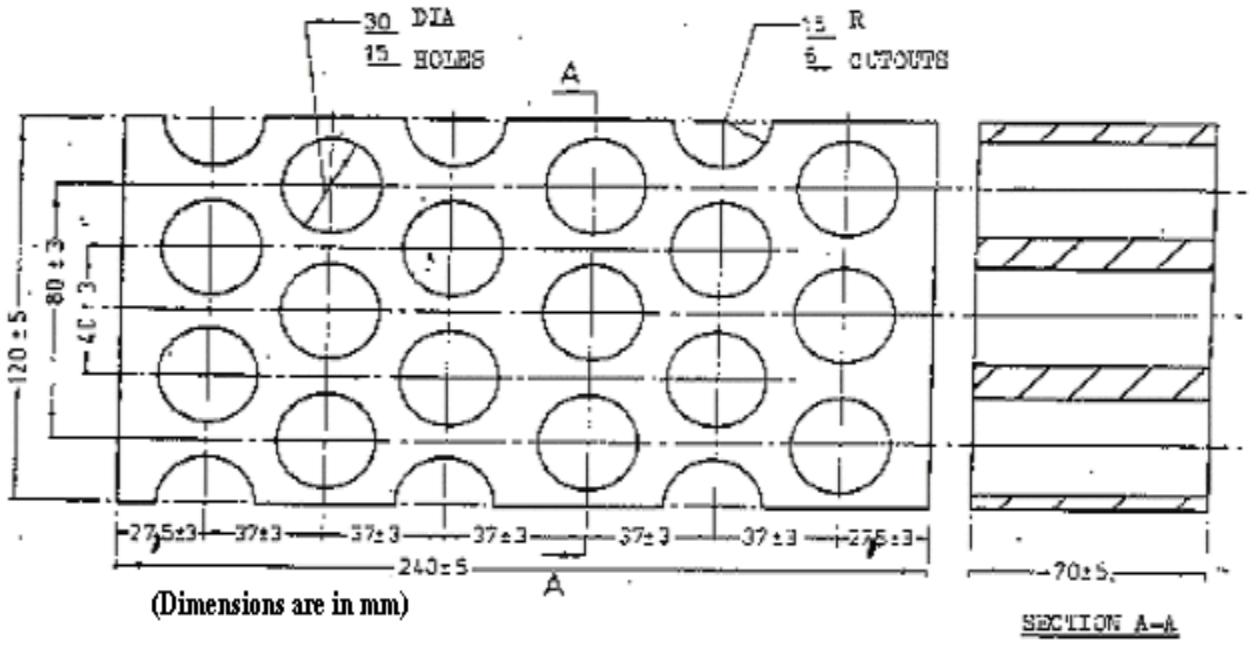
Annex 5 - Appendix 2

DIMENSIONS AND TECHNICAL DATA OF FIREBRICKS



Fire resistance	(Seger-Kegel) SK 30
Al_2O_3 content	30 - 33 per cent
Open porosity (P_o)	20 - 22 per cent vol.
Density	1,900 - 2,000 kg/m^3
Effective holed area	44.18 per cent

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